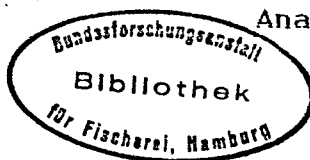


INTERNATIONAL COUNCIL FOR THE
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Anadromous and Catadromous
Fish Committee



Homing of tagged sea trout.

(*Salmo trutta* L.) smolts released into Polish rivers

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ABSTRACT

In the years 1961 - 1986 there were tagged about 183 000 sea trout smolts which were released into the Vistula River system, the Pomeranian rivers, and the Gulf of Gdańsk. The Vistula River stockings showed the highest percentage of recaptures in rivers. Almost all the fish were caught in the Vistula River system. A lot of sea trouts from stockings of the Pomeranian rivers went astray and they were recaptured either in the Vistula River or in the Pomeranian rivers. It seems that local Pomeranian sea trout may be a mixture of populations stemming from neighboring rivers. It concerns, in particular, the cases when the share of smolts from stocking is very high.

INTRODUCTION

The populations of sea trout (*Salmo trutta* L.) in Poland have dwindled due to rivers damming and to increasing pollution. In order to increase the numerical force of populations there is carried out an annual compensation stocking which reached 168 000 to 932 000 of smolts per annum in the years 1972 - 1993. The smolts were released into the rivers' estuaries and rather seldom to the middle or upper rivers, or directly into the sea. The spawn for smolts rearing is obtained from the spawners migrating to perform the spawning. These spawners show a tendency of entering the same rivers from which they had come to the sea as smolts. Despite such a great precision of homing some of the fish go

astray and do not enter the mother river (Bertmar, 1979). In the case of smolts released directly into the sea we can exclusively speak about a considerable stray resulting from lack of marks enabling finding their way to rivers' estuaries (Larsson, 1977; Bertmar, 1982; Einarsson et al., 1987; Anon, 1993).

The aim of this work was firstly to estimate the degree of mistaken selection of the river by the sea trout spawners, migrating to the spawning grounds, and secondly - to estimate the influence of stray on mixing of sea trout population in Polish rivers.

MATERIAL AND METHODS

The elaboration of this paper was based on the results from 135 tagging experiments of sea trouts carried out by the Laboratory of River Fishery of the Inland Fisheries Institute in the years 1961 - 1986. The experiments were carried out in over twenty hatcheries where 182 682 sea trout smolts, having the length between 131 and 282 mm, and the age from 1 to 3 years, mainly 2 years, were tagged (Tab.1). In particular experiments the number of smolts varied from 21 to 9 984 individuals. All the smolts were tagged with celluloid tags, having either single monel or silver wire, which were being attached under the dorsal fin. The tagged fishes were released into the Vistula River or its tributaries, into the Pomeranian rivers, or into the Gulf of Gdańsk, in the period March - June (Fig.1).

Out of the released smolts there were 10 116 recoveries and the percentage of recaptures in particular experiments varied from 0 to 33.8.

The analysis of the material was performed on the basis of summed up data from the experiments carried out in particular rivers in various years. The following parameters were determined: 1) the distance between the place of release and the sea, 2) total number of smolts released in different stocking places, 3) number of smolts released in particular spot, 4) number (N) and percentage ($N \times n^{-1} \%$) of recoveries, 5) number (R) and percentage ($R \times n^{-1} \%$) of recaptures in fresh water, 6) percentage of recoveries in freshwater to a total number of recoveries ($R \times N^{-1}$), and 7) the number (D) and percentage ($D \times R^{-1} \%$) of fish caught in the mother river (Tab.1). The returns of tags from the sea trout caught in the Pomeranian rivers were treated globally for each concerned river. The sea trouts were being caught below the first dam, at a small distance from the sea; the biggest.

distance from the sea was in the case of the Słupia River (35 km), the Parsęta River, or the Łeba River (3 - 5 km from the estuary - namely in the lake). What concerns the Vistula River the tags returns were divided into several groups; the first one encompassed the returns from fish caught in the Vistula estuary which means the lower Vistula and the river current in the Gulf of Gdańsk; the upper parts of the Vistula River were divided into 4 sections - namely: the lower Vistula, the Vistula River to Drwęca estuary, the river part to the dam in Włocławek, and the Vistula River above the dam in Włocławek with an inclusion of all the Vistula tributaries in this section. In addition to the above division the Drwęca River was treated separately. The Vistula Firth was included to fresh water section, despite the fact that there is present brackish water (Fig.1).

RESULTS

The highest percentage of returns was observed in the case of sea trouts released into the Vistula River, at the distance of 74 km from the river mouth, and into Drwęca mouth (214 - 223 km from the estuary), and it was 10.2 % and 9.0 % , respectively. The lowest tag recoveries were seen in the case of tagged smolts released into tributaries of upper Vistula, and into upper Drwęca, and they were 1.1 and 2.7 % , respectively.

The results suggest that the percentage of tags recoveries was decreasing with an increasing distance between the place of stocking and the Vistula estuary (Tab.1).

Similarly, the highest percentage of returned tags, from the fish caught in freshwater, was observed in the case if fish released into the Drwęca mouth and into the Vistula River at the distance of 74 km from the river's mouth, and it was 4.7 and 3.4 % , respectively. The lowest results were from stockings in the upper Drwęca and tributaries of upper Vistula, and they were 0.9 and 0.6 % , respectively (Tab.1).

The sea trouts caught in fresh water made up 32.5 and 37.8 % of all the recoveries from the stockings of lower parts of Vistula and the upper Drwęca. Out of the smolts released into the lower Drwęca and into tributaries of the upper Vistula the share of sea trout caught in freshwater, as compared with all the tags returns from the fish caught for the second time, exceeded 50 % (Tab.1).

Nearly all the tags returns from the sea trout caught in freshwater from the stocking of Vistula catchment area in 94 to 99.3 % originated from this catchment area (Tab.1). Only single

individuals were caught in the Vistula Firth or in the following Pomeranian rivers: Rega, Odra, Parsęta, Wieprza. Their share varied from 0.05 to 0.60 % of a total number of returns (Fig. 2 - 5), which made up from 0.7 to 2 % of a total number of fish caught in inland water, with the Vistula Firth being included to these waters (Fig 2 - 5).

The sea trout released into the Vistula estuary, into the lower Vistula, and into its upper tributaries, when entering the Vistula River as spawners were, most often, caught in the lower Vistula. They reached the vicinity of Włocławek (Fig 2 - 5), and only single individuals were caught above the dam in Włocławek (Fig 2 and 3). However, the sea trout from this stocking did not enter the Drwęca River (Fig 2 - 5),

The tagged sea trout from the Drwęca stocking when migrating along the Vistula River were, most often, caught in the lower Vistula or entered the Drwęca River. The spawners originating from these stockings, when migrating towards the upper Vistula River would only enter the Drwęca River, but they were not observed in the Vistula River, above the estuary of Drwęca (Fig.6 and 7).

The average percentage of tags returns from the sea trout smolts released into the Pomeranian rivers were similar to the results from stocking of upper Drwęca and of tributaries of the upper Vistula, and they fluctuated between 0.7 % (Słupia) and 3.9 % (Leba) (Tab.1). Among them, the share of sea trouts caught in the inland waters and in the Vistula Firth was considerably lower than in the case of sea trout catches from the Vistula and Drwęca stocking and it ranged from 0.1 to 1.0 % of tags returns, as compared with a total number of smolts released into river; they made up from 10.7 (Reda) to 29.8 % (Parsęta) as compared with a total number of recaptures, from particular rivers (Tab.1). Among the sea trout spawners originating from the Pomeranian rivers and entering the rivers and the Vistula Firth there was observed much higher percentage of fish going astray than in the case of the sea trout released into the Vistula River. This percentage reached 89.3 and 82.4 % for the sea trout of Parsęta and Słupia, respectively, and even 100 % in the case of Lupawa River. Only the sea trout of the remaining rivers namely Wieprza, Reda, and Leba, showed a lower percentage with respect to entering the "foreign river" and it varied from 19.8 to 30.8 % (Tab.1). The sea trout which did not enter the river, to which they had been released as smolts, were caught in other Pomeranian rivers and in the Vistula River. In the Vistula River they were caught most often and they made up from 17.4 (Leba) to 57.6 % (Lupawa) of the sea trout

obtained in freshwater and in the Vistula Firth (Fig 8 - 12), or from 0.19 (Słupia) to 4.33 % (Lupawa) of returns - as compared with the released number of smolts (Fig 8 - 12). Only the sea trout smolts released into the Parsęta River did not become the individuals caught in the Vistula River (Fig 13).

The highest percentage of returns (12.6) was obtained from the stocking with smolts of the Gulf of Gdańsk, and out of this number 1.2 % of the sea trouts were caught in 7 rivers and in the Vistula Firth. They were mainly caught in the Vistula estuary and in the Vistula River (10.59 ‰). The release of smolts into the Gulf of Gdańsk, at the distance of a few km westwards from the Vistula estuary, resulted in the fact that among the sea trouts entering the freshwater as much as 89.2 % were caught in the Vistula River (Fig 14).

DISCUSSION

The basic problem arising when interpreting the results of tagging, stems from the fact that there are two factors which are difficult to estimate and they are as follows: losing of tags by fish or lack of tags sending by the fishermen. Salminen (1991) considers losing of tags as a main source of errors in estimation of tagging results. The percentage of lost tags depends on numerous factors and the estimates presented by different authors vary considerably. The estimate given by Issakson and Bergman (1978) is 10 %, while Swain (1971) gives - 17 %, Arnason and Mills (1987) - from 1 to 70 %, and Earnes and Hino (1983) - less than 4 %. According to the Report of the Baltic Salmon and Trout Assessment Working Group (ICES, 1991) the percentage of tags lost by salmon in the Baltic Proper ranged from 20 % in 1988/89 season, to 10 % in 1989/90 and 30 % in 1990/91. Wiśniewolski and Nabiałek (1993), based on tagging experiments of Cyprinidae, the latter kept in ponds, state that losing of tags may result in erroneous estimation of mortality. Therefore these authors have proposed a correction of such errors by application of mathematical function which would regard the type of tag and the time which passed since the tagging experiment. The tag's attachment to fish body is greatly affected by both the tagging technique and the experience of a person performing the experiment (Shearer, 1977).

The differences in percentage of tags returns, being dependent on experience of a tagging person were threefold in studies by Elson and Willianson (1972). Even bigger discrepancies, from 4 to 95 %, are mentioned by Ritter (1973).

The presence of tag in fish body may increase the catch of

small fish due to tangling of the tag in the net (Sych and Bartel, 1976).

The fact that tags are not returned by the fishermen also makes the tagging experiment more difficult (Porter, 1979). With this respect the information on tagging was spread among those involved, however, the response had rather a local character. The better results are in the case of those regions where the contacts with fishermen are more frequent, e.g. the region of Vistula estuary gives better results than the Pomeranian rivers.

The obtained results raise a question to what extent the sea trout straying may affect the genetic purity of sea trout in Polish rivers. This item should be dealt with separately for the population of Vistula and Pomeranian sea trout rivers. What concerns the latter the returns of migrating fish to the spawning grounds of rivers into which they had been released as smolts, is much less evident than in the case of trout released into the Vistula River. The smolts release into the Pomeranian rivers estuaries, which have the average flow velocity low ($2.25 \text{ m}^3/\text{sec}$ at Reda estuary; $5.68 \text{ m}^3/\text{sec}$ - Lupawa; $14.6 \text{ m}^3/\text{sec}$ - Parsęta (Kostrzewa, 1972)), are less affected than the smolts released into the Vistula estuary, where the lowest average flow velocity reaches $371 \text{ m}^3/\text{sec}$ (Kostrzewa, 1972).

The smolts which have entered the Gulf of Gdańsk remain, for some time, in the stream of the Vistula water. This factor may have a decisive influence on a high percentage of sea trout returns to their mother river. The obtained results allow to state that the stocking of estuaries of the Pomeranian rivers with smolts leads to mixing of populations. However the share of Pomeranian trouts in population of Vistula trout is insignificant.

The available materials do not give the right to treat the trout from the Pomeranian rivers as a one population, because it can not be excluded the fact that the spawner originating from the natural spawning or from the stocking with fry, will have visibly higher percentage of returns to their mother river. The sea trout which come from different rivers and enter the Vistula River are of less importance as they are more often being caught in the lower Vistula, and only not numerous individuals reach the spawning grounds. The possible influence of those entering spawners of foreign origin is being reduced by increased numbers of smolts introduced into the Vistula River, which are 2 - 3 times bigger than a number of smolts introduced into the Pomeranian rivers.

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Table 1. The distance between the place of release and the sea, total number of smolts released in different stocking places, number of smolts released in particular spot, number /N/ and percentage /N x n⁻¹%/ of recoveries, number /R/ and percentage /R x n⁻¹%/ of recaptures in fresh water, percentage of recoveries in freshwater to a total number of recoveries /R x N⁻¹/, and the number /D/ and percentage /D x R⁻¹%/ of fish caught in the mother river.

River Place of release	km	n	N /Nxn ⁻¹ %/	R /Rxn ⁻¹ %/	RxN ⁻¹ %	D /DxR ⁻¹ %/
Vistula	2-11	30460/21/	2066 /6.8/	671/2.2/	32.5	666/99.3/
	74	18373 /7/	1873/10.2/	621/3.4/	33.2	609/98.1/
	240-270	6406 /7/	402 /6.3/	152/2.4/	37.8	149/98.0/
	Drwęca	214-223	7872 /6/	711 /9.0/	367/4.6/	51.6
	408	11255 /5/	302 /2.7/	100 /0.9/	33.1	94/94.0/
tribut. upper Vistula	830-951	21244/13/	226 /1.1/	128/0.6/	56.6	127/99.2/
Vistula system		95610/59/	5580/5.8/	2039/2.1/	36.5	2011/98.6/
Reda	1-7	8083 /7/	122/1.5/	13/0.2/	10.7	9/69.2/
Łeba	0	21076/14/	815/3.9/	212/1.0/	26.0	170/80.2/
Łupawa	0-40	4336/4/	145/3.3/	33/0.8/	22.8	0/0.0/
Słupia	0	15403/9/	103/0.7/	17/0.1/	16.5	3/17.6/
Wieprza	0-25	9121/8/	214/2.4/	40/0.4/	18.7	29/72.5/
Paręta	0	4970/4/	94/1.9/	28/0.6/	29.8	3/10.7/
Gulf of Gdańsk		24083/30/	3043/12.6/	286/1.2/	9.4	

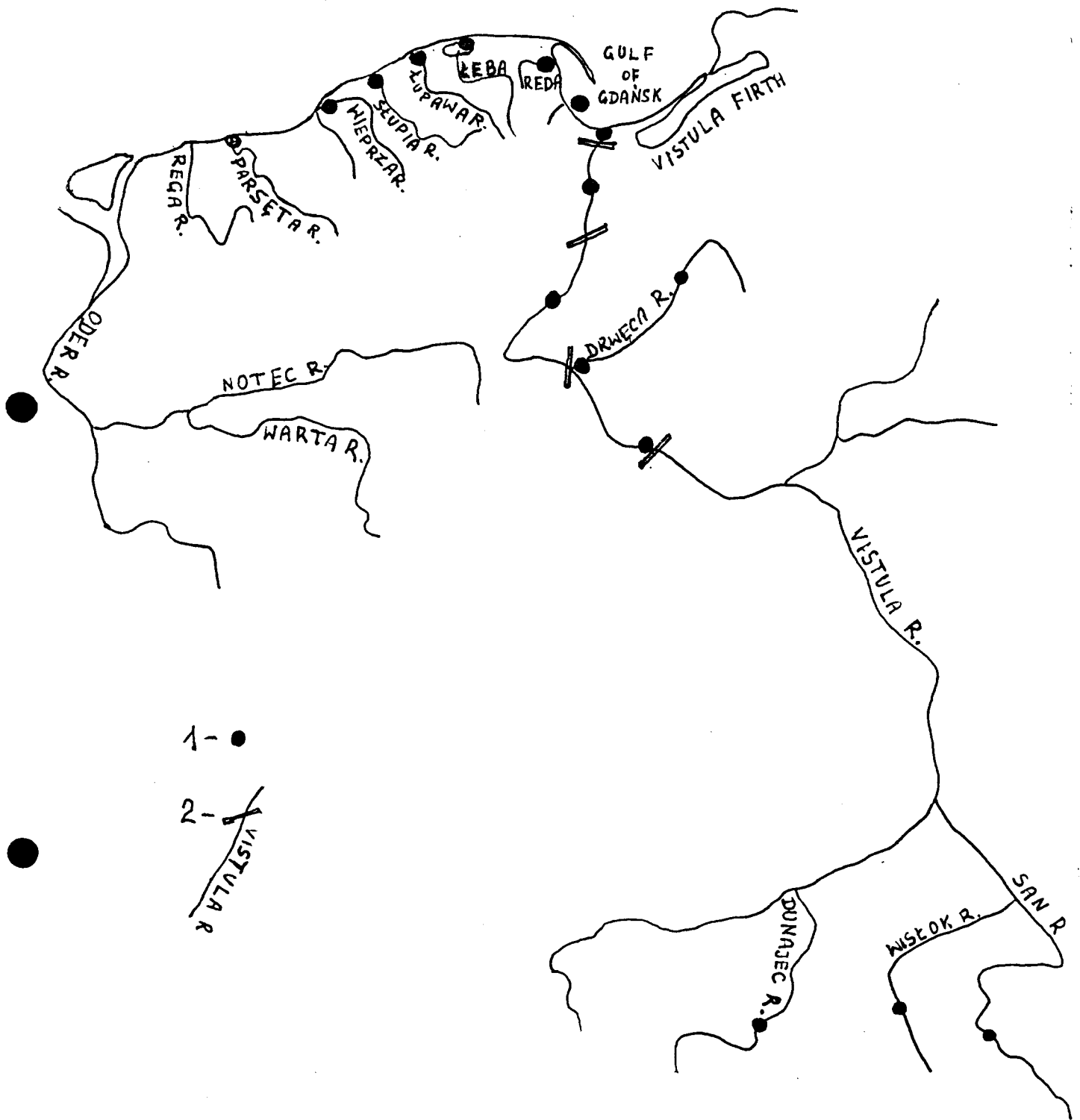


Fig.1. Places of releasing of tagged smolts, 1 - place of releasing, 2 - borders of contractual parts of the Vistula River Basin.

Fig.2. Freshwater recapture of sea trout smolts released into the Vistula River mouth, 1 - a place of release of sea trout smolts, 2 - freshwater recaptures in promilles from sea trout smolts, 3 - percentage of freshwater recaptures, 4 - borders of contractual parts of the Vistula River Basin.

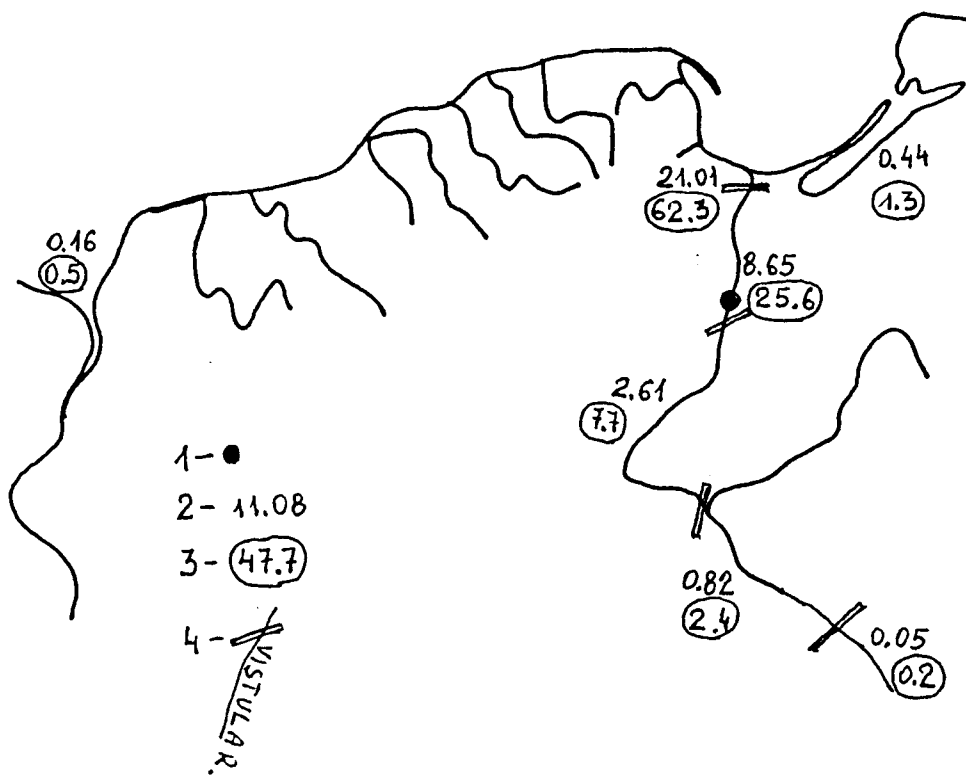
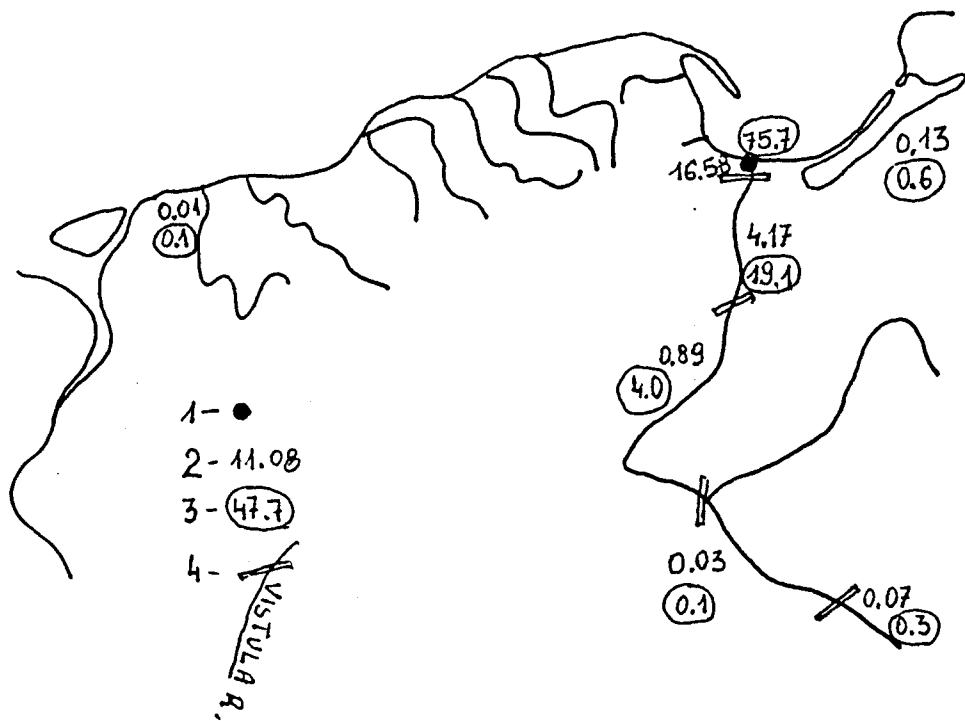


Fig.3. Freshwater recaptures of sea trout smolts released into the lower Vistula River. Explanations as in Fig.2.

Fig.4. Freshwater recaptures of sea trout smolts released into the Vistula River, near Włocławek dam. Explanations as in Fig.2.

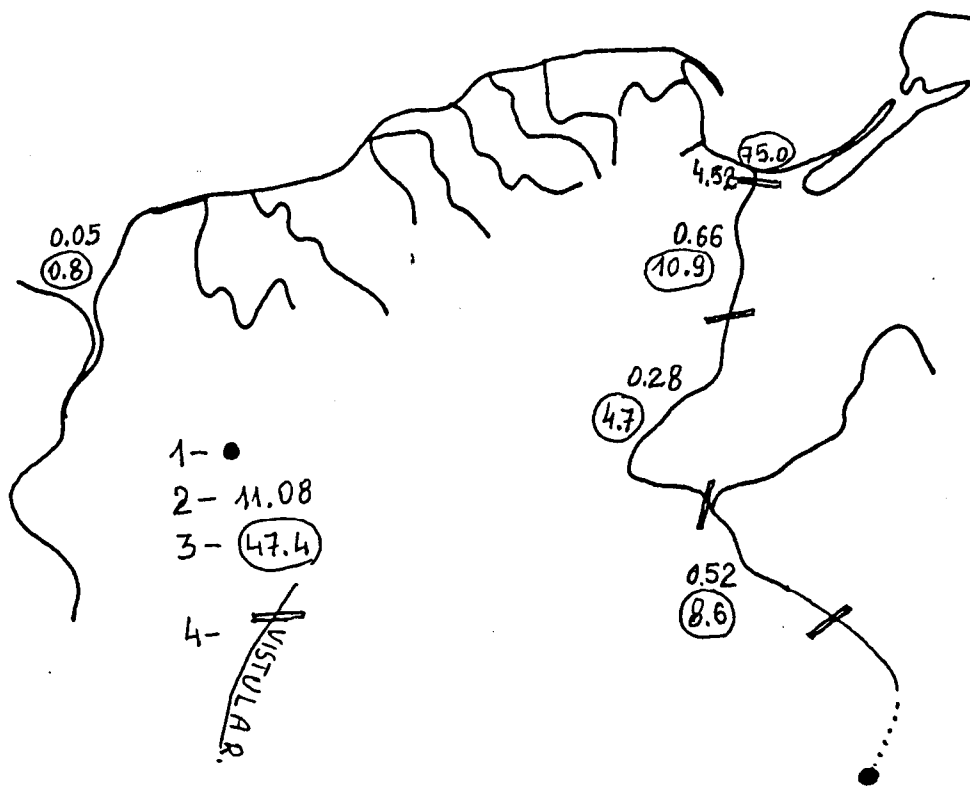
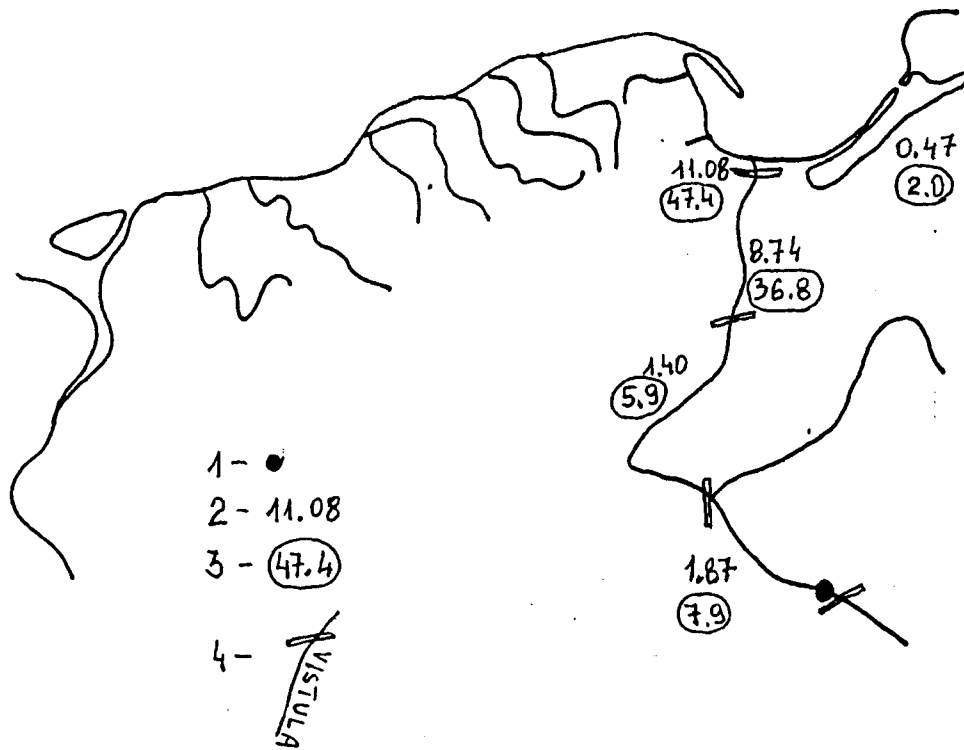


Fig.5. Freshwater recaptures of sea trout smolts released into tributaries of the upper Vistula River. Explanations as in Fig.2.

Fig.6. Freshwater recaptures of sea trout smolts released into the lower Drwęca River. Explanations as in Fig.2.

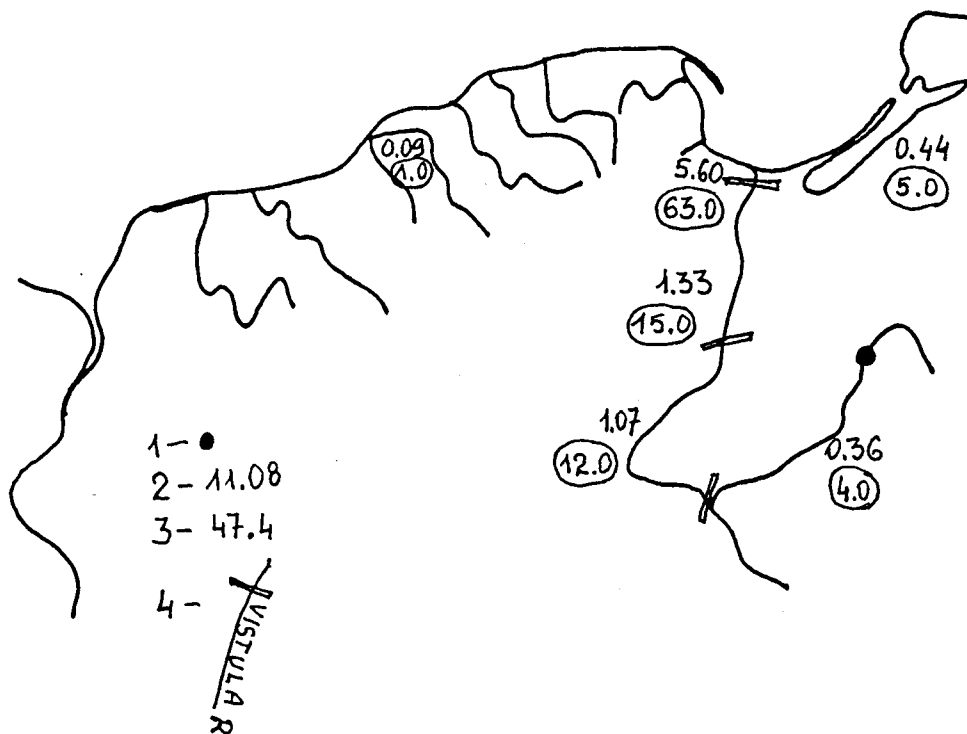
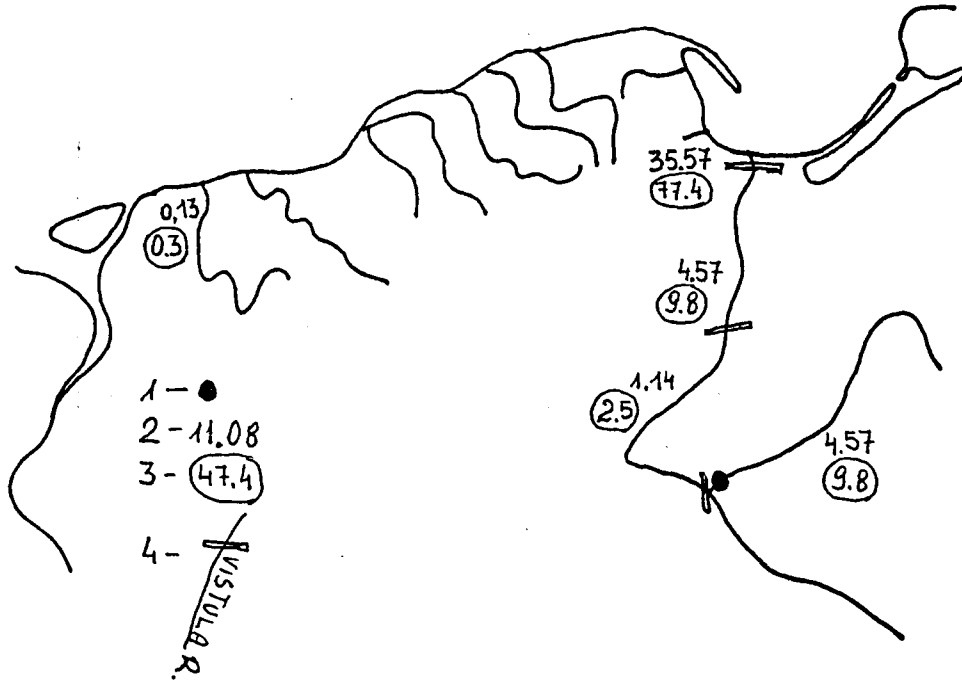


Fig.7. Freshwater recaptures of sea trout smolts released into the upper Drwęca River. Explanations as in the Fig.2.

Fig.8. Freshwater recaptures of sea trout smolts released into the Reda River. Explanations as in Fig.2.



Fig.9. Freshwater recaptures of sea trout smolts released into the Łeba River. Explanations as in Fig.2.

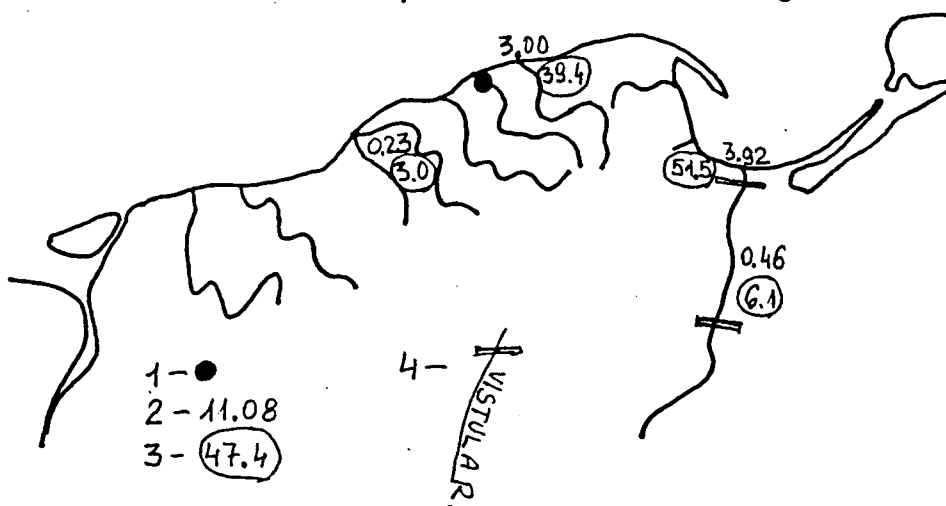


Fig.10. Freshwater recaptures of sea trout smolts released into the Lupawa River. Explanations as in Fig.2.

Fig.11. Freshwater recaptures of sea trout smolts released into the Słupia River. Explanations as in Fig.2.

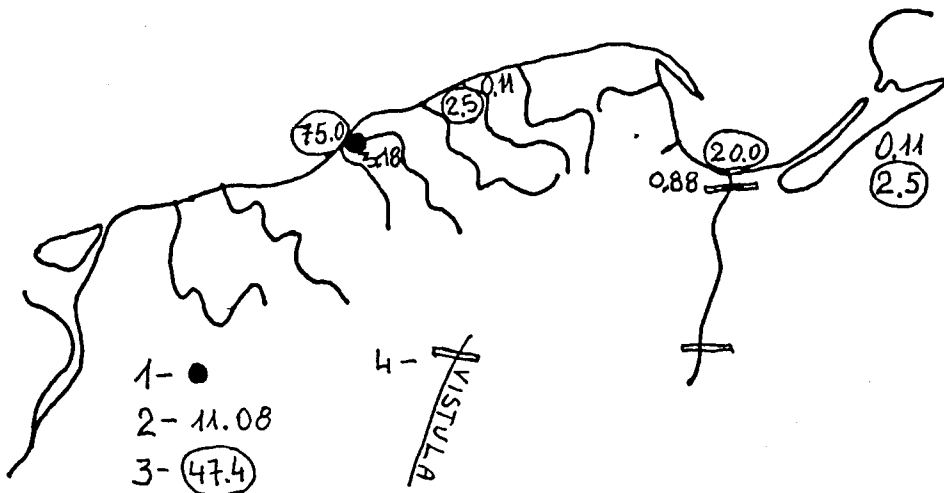
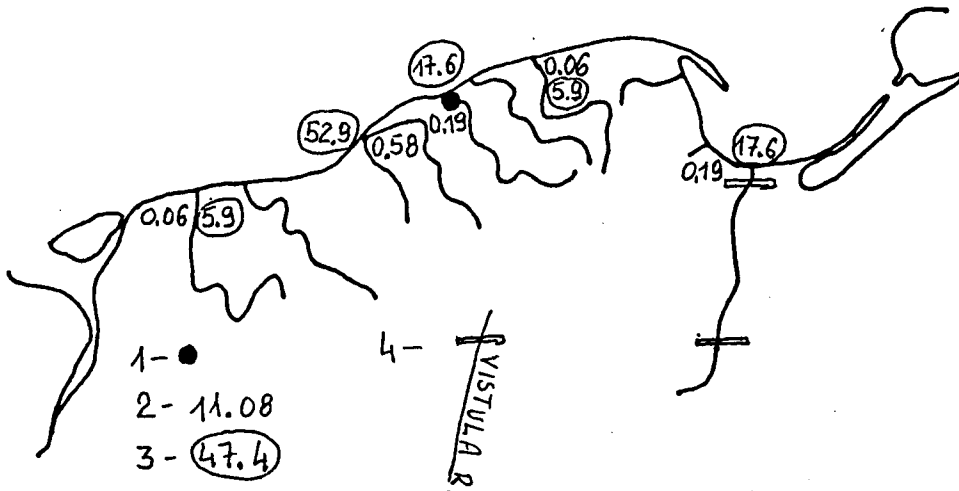


Fig.12. Freshwater recaptures of sea trout smolts released into the Wieprza River. Explanations as in Fig.2.

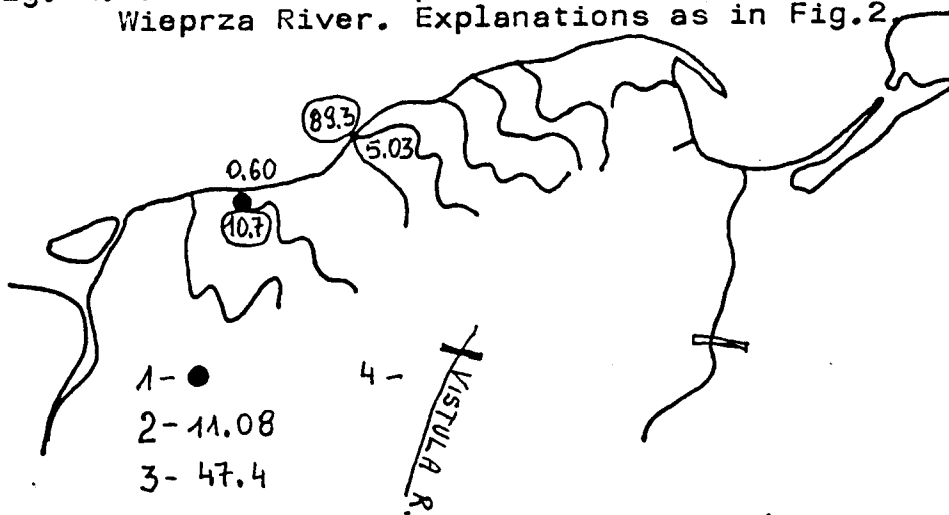


Fig.13. Freshwater recaptures of sea trout smolts released into the Parsęta River. Explanations as in Fig.2.

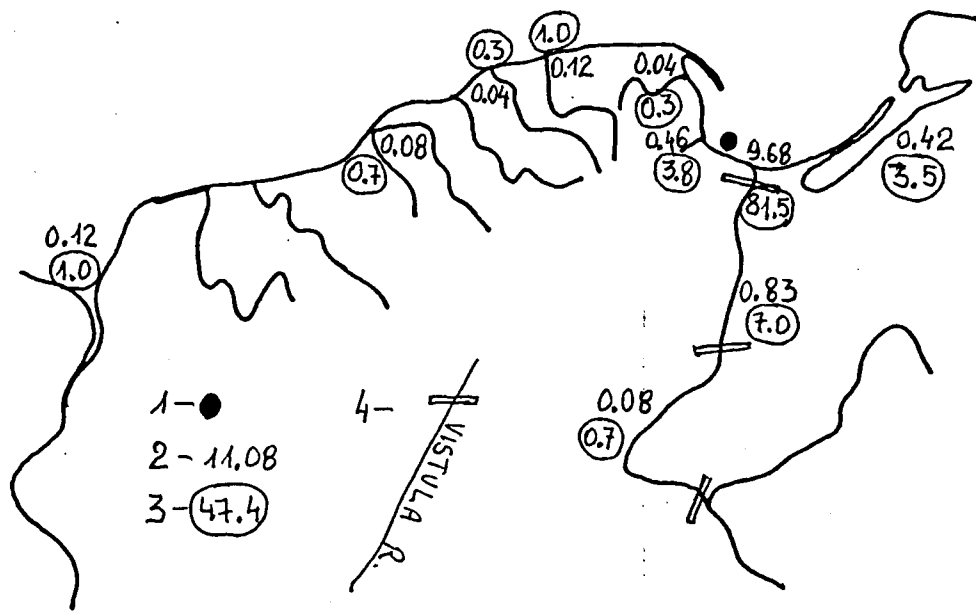


Fig.14. Freshwater recaptures of sea trout smolts released into the Gulf of Gdańsk. Explanations as in Fig.2.